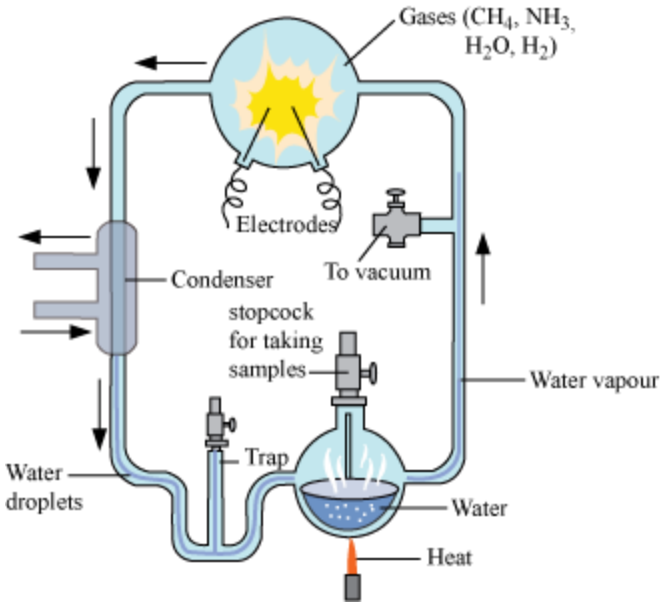
Evolution

Origin of Life

Year	Scientist	Theory/Experiment	Conclusion
1927	Lemaitre	Big Bang theory	The universe expanded from explosion of a primordial, hot substance.
1924 – 1929	Oparin and Haldane	Chemical evolution preceded organic evolution	Simple organic molecules originated from inorganic precursors.
1952	Stanley Miller and Urey	Synthesis of biomolecules by creation of similar conditions as primitive atmosphere on laboratory scale	Amino acids were synthesised from ammonia, oxygen, and carbon dioxide inside specialised apparatus.

Urey and Miller experiment



- Primitive atmosphere had high temperature, volcanic storms, and reducing atmosphere, containing CH_4, NH_3, H_2, etc.
- Urey and Miller took the same compounds in a closed flask along with water vapour at 800°C and created an electric discharge.
- Formation of biomolecules such as amino acids, simple sugars, fats, etc. was observed in the flask.

Theories of Evolution

- The theory of special creation or divine intervention was challenged by Charles Darwin.
- He made observations on his sea-trip around the world aboard H.M.S.

Beagle and concluded that all existing living forms share similarities among themselves and also with other life forms, which existed millions of years ago of which many are extinct.

- The evolution of life forms has been gradual and those life forms better fit in environments that leave more progeny. This is called natural selection and is a mechanism of evolution.
- Alfred Wallace working in the Malay Archepelago also came to the same conclusion.

Evidences of Evolution

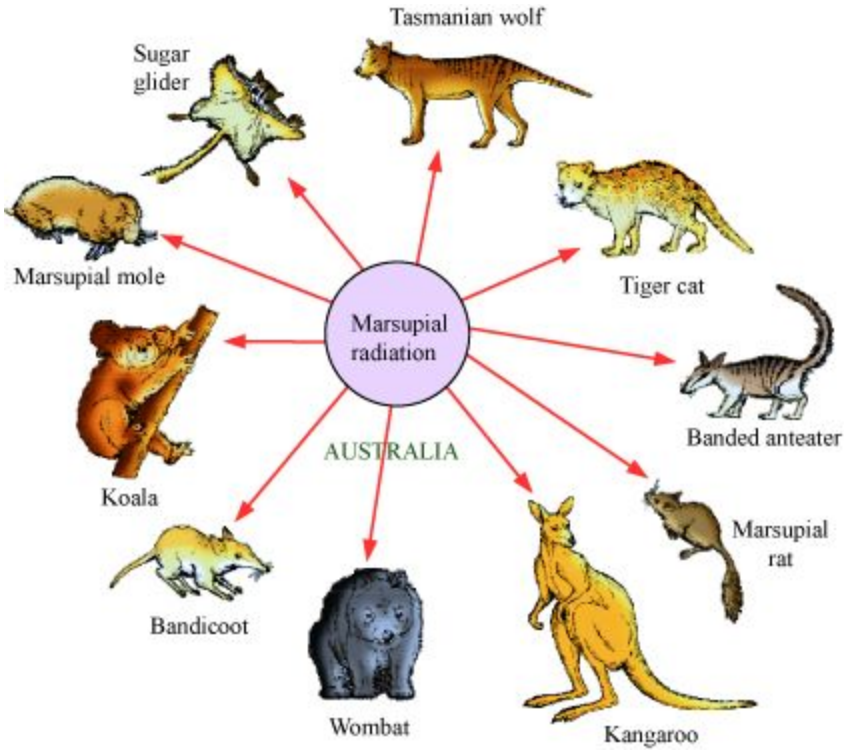
- **Fossils** – They represent plants and animals that lived millions of years ago and are now extinct. Different aged rock sediments contain fossils of different life-forms, which probably died during the formation of the particular sediment.
- **Comparative anatomy and morphology** – It shows evidences of the similarities and differences between living forms of today and that of the prehistoric times. Some of the examples of comparative anatomy and morphology are:
- **Homologous organs** – All mammals share the same pattern of forelimbs. Though they perform different functions, they are anatomically similar. This is called **divergent evolution** and the structures are called homologous structures (common ancestors).
- **Analogous organs** – The pair of organs is not anatomically similar, but performs the same function (e.g., the wings of butterflies and birds). This is called **convergent evolution**.
- **Adaptive melanism** – In England, it was noted that before industrial revolution, the number of white-winged moths was more than that of dark melanised moth. However, after industrialisation, there were more of dark melanised moths. The explanation was that after industrialization, the tree trunks became darker with deposits of soot and smoke and hence, the number of dark moths increased in order to protect themselves from predators while the white-winged ones were easily picked up by the predators.
- Similarly, the herbicide and pesticide resistant plants and animals and antibiotic resistant bacteria are some of the evidences that point towards evolution.

Adaptive Radiation

- During his exploration of the Galapagos Islands, Darwin noticed that there were many varieties of finches in the same island.
- They varied from normal seed eating varieties to those that ate insects.
- This process of evolution starting from a single point and radiating in

different directions is called adaptive radiation.

- The other example for this is the evolution of the Australian marsupials from a single ancestor. Placental mammals also exhibit similarities to their corresponding marsupial. Example: placental wolf and the Tasmanian wolf
- When more than one adaptive radiation occurs in an isolated geographical area, the phenomenon is called convergent evolution.



Biological Evolution & Mechanism of Evolution

- According to Darwin, evolution took place by natural selection.
- The number of life forms depends upon their ability to multiply and their life span.
- Another aspect of natural selection is the survival of the fittest, where nature selects the individuals, which are most fit, to adapt to their environment.
- **Branching descent** and **natural selection** are the two important concepts of Darwin's theory of evolution.
- The French naturalist Lamarck observed that evolution occurs due to

the use or disuse of particular organs or body parts. For example, giraffe have developed long necks as a result of attempts to eat leaves high up on trees.

- Darwin also observed that variations are inheritable and the species fit to survive the most, leaves more offsprings. Hence, the population's characteristics change, giving rise to the evolution of new life forms.

Mechanism of Evolution

- Darwin did not quite explain how evolution gave rise to different species of the same organism.
- Mendel mentioned about inheritable factors, which influenced the phenotype of an organism.
- Hugo de Vries based on his work on evening primrose suggested that variations occurred due to mutations.
- Mutations are random and directionless while the variations that Darwin talked about were small and directional. Hugo de Vries gave the name **saltation** (single step large mutation) to the mutations which brought about speciation.

Hardy-Weinberg Principle

- The frequency of occurrence of alleles of a gene in a population remains constant through generations unless disturbances such as mutations, non-random mating, etc. are introduced.
- Genetic equilibrium (gene pool remains constant) is a state which provides a baseline to measure genetic change.
- Sum total of all allelic frequencies is 1.
- Individual frequencies are represented as p and q such as in a diploid, where p and q represent the frequency of allele *A* and *a*.

The frequency of *AA* is p^2, that of *aa* is q^2, and that of *Aa* is 2pq.

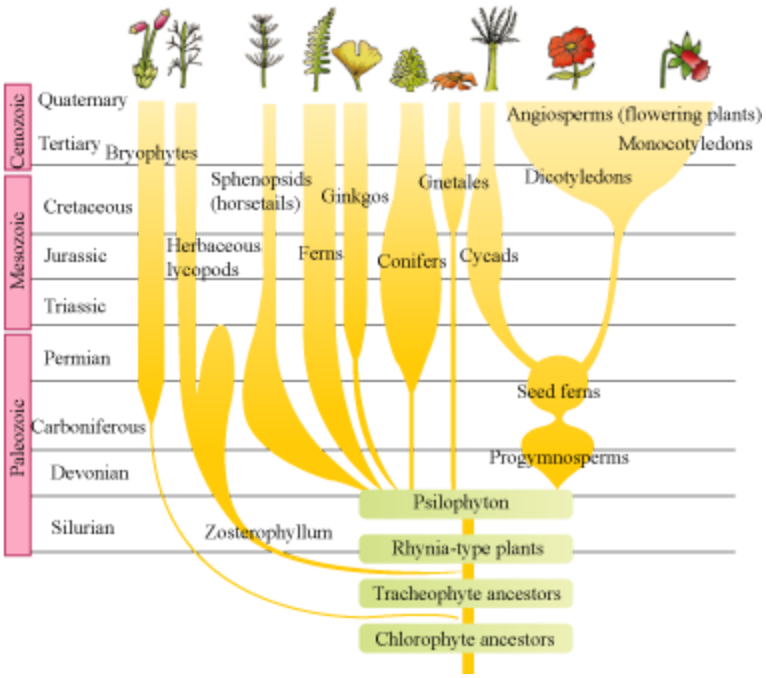
- Hence, $p^2 + 2pq + q^2 = 1$, which is the expansion of $(p + q)^2$.
- When the frequency measured is different from that expected, it is indicative of evolutionary change.
- Hardy-Weinberg equilibrium is affected by

- gene flow or gene migration
- genetic drift (changes occurring by chance)
- mutation
- genetic recombination
- natural selection
- Sometimes, the change in allele frequency is so prominent in the new sample of population that they become a different species and the original drifted population becomes the founder. This effect is called founder effect.
- The advantageous mutations that help in natural selection over the generations give rise to new phenotypes and result in speciation.

Evolution of Plants and Animals

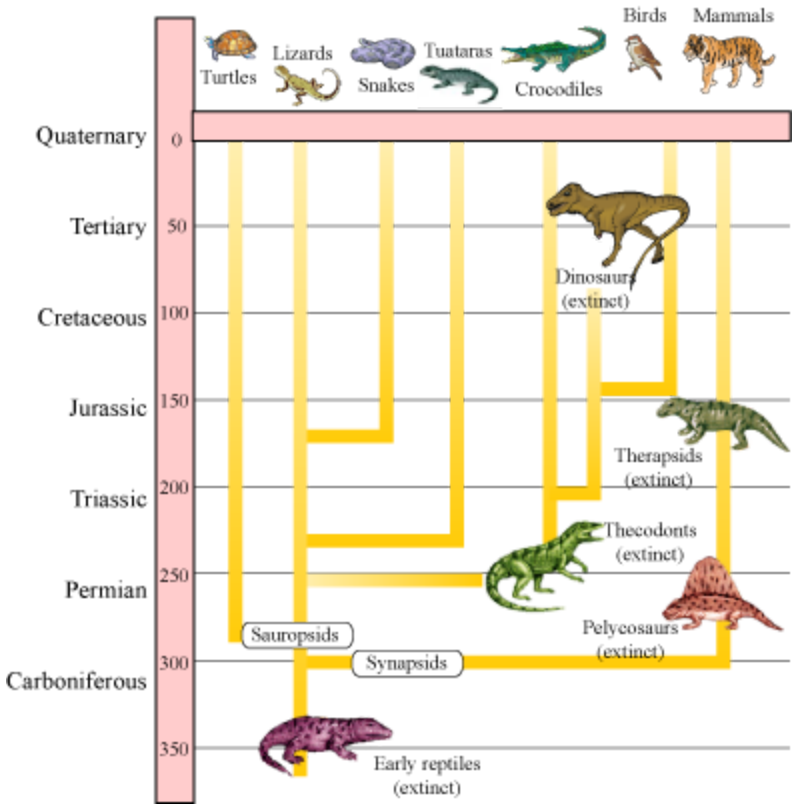
Evolution of Plants

- Cellular life forms occurred on earth about 2000 million years ago.
- Some of these cells had the ability to produce oxygen through reactions similar to photosynthesis.
- Slowly, single-celled organisms became multicellular.
- Seaweeds and some plants probably existed around 320 million years ago.



Evolution of Animals

- Animals evolved about 500 million years ago. The first of them to evolve were invertebrates.
- Jawless fishes evolved around 350 million years ago.
- Some of the fishes could go on land, and then come back to water. These were the first amphibians. In 1938, a fish Coelacanth, which was thought to be extinct, was caught in South Africa. This variety of fish, called lobefins, is believed to have evolved into the first amphibians.
- Amphibians evolved into reptiles. In the next 200 million years, reptiles of different sizes dominated the earth. However, about 65 million years ago, some of them such as dinosaurs disappeared.
- The first among the mammals were small shrew-like mammals.
- During continental drift when North America joined South America, primitive mammals suffered, but pouched mammals of Australia survived the same drift because of lack of competition from other mammals.



Origin and Evolution of Man

Year	Evolution	Characteristics
15 million years ago	*Dryopithecus* (ape-like) and *Ramapithecus* (man-like)	Hairy and walked similar to chimpanzees
3 – 4 million years ago	Man-like primates	Not tall, but walked straight
2 million years ago	*Australopithecines*, also called *Homo habilis*,lived in East Africa	Used stone weapons and ate fruits; human-like with brain capacity of 650 – 800 cc; not meat eaters

1.5 million years ago	*Homo erectus*	Brain capacity of about 900 cc; were meat eaters
1,000 – 40, 000 years ago	Neanderthal man	Brain capacity of 1400 cc; used hides
75, 000 – 10, 000 years ago	*Homo sapiens*	

When we compare the skulls of an adult human being, baby chimpanzee, and adult chimpanzee, we observe that skull of baby chimpanzee resembles human being more as compared to adult chimpanzee.